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(54) Title: SUBMERSIBLE ELECTRONICS MODULE AND SUBMERSIBLE PUMP ASSEMBLY WITH SUCH

(57) Abstract: The present disclosure is directed to a submersible electronics module (17) enclosing electronics (18, 47, 49), wherein the submersible electronics module (17) has a first end section (23) and a second end section (25), wherein the first end section (23) of the submersible electronics module (17) comprises a first coupling section being releasably couplable to a submersible pump module (13), wherein the second end section (25) of the submersible electronics module (17) comprises a second coupling section being releasably couplable to a submersible motor module (15), wherein the submersible electronics module (17) comprises an interme- diary drive shaft section (45), wherein the intermediary drive shaft section (45) is releasably couplable to a motor drive shaft section (43) of the submersible motor module (15) for receiving a torque from the motor drive shaft section (43), and wherein the intermediary drive shaft section (45) is releasably couplable to a pump drive shaft section (35) of the submersible pump module (13) for transferring the torque to the pump drive shaft section (35).

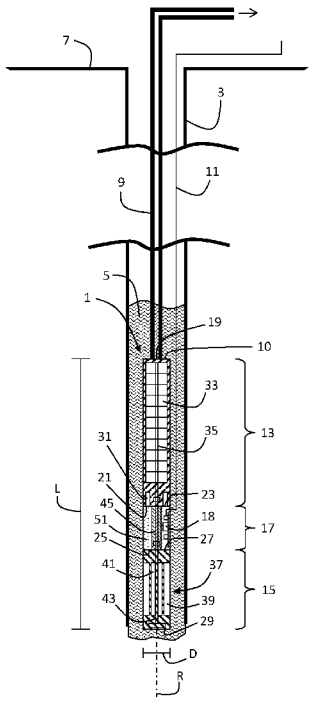

Fig. 1

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Description

TECHNICAL FIELD

[01] The present disclosure relates generally to submersible pump systems, more particularly to submersible pump assemblies with a slim shape extending along the longitudinal axis for lowering the submersible pump assembly into a borehole.

BACKGROUND

[02] Typically, submersible pump assemblies are used to pump water or another liquid medium upward out of a borehole, a well or a tank. Therefore, the submersible pump assembly is lowered along its longitudinal axis into a borehole, well or storage tank into the liquid to be pumped upwards. Usually, the submersible pump assembly comprises a submersible pump module and a submersible motor module being coupled to each other. A top end of the submersible pump module comprises a pressure outlet connected to a flexible and/or rigid riser duct for pumping liquid upward through the riser duct to a point of use at the surface. The riser duct is also used to mechanically lower down and pull up the submersible pump assembly. Typically, an electrical power line extends from the surface down to the submersible motor module for powering the motor. Control electronics for controlling the speed of the motor are known to be located at the surface, wherein a data transmission between the control electronics and the motor is facilitated by the power line and/or a separate communication line.

[03] EP 2 630 329 B1 describes a submersible pump system, wherein the control electronics are integrated into the submersible motor module. A disadvantage of the solution described in EP 2 630 329 B1 is that the power line and the sensor cable must pass laterally along the submersible motor module, which limits the available lateral space for the motor.

[04] The integration of the control electronics into the submersible motor module has, compared to a control module at the surface, the benefit that less equipment and cables are needed for the communication between the control module at the surface and the submersible motor module. However, it has a disadvantage for maintenance and repair, because the control electronics cannot be accessed without disassembling the submersible motor module. Furthermore, a large variety of submersible motor modules with an integrated control module is needed.

[05] Submersible pump assemblies of this kind usually have a slim shape, because they are, for example, lowered into a borehole or through a small opening into a tank or well. Therefore, the slimmer the submersible pump assembly is, the more versatile it can be used. However, the motor power is limited depending on the lateral size of the submersible pump assembly.

[06] It is therefore an object of the present disclosure to provide a submersible pump assembly that uses its lateral size as efficiently as possible, is easier to maintain and repair, and which reduces the variety of submersible motor modules needed to provide a broad range of variants of submersible pump assemblies in terms of power and size.

SUMMARY

[07] The subject-matter of the independent claims provides a solution to this problem according to the present enclosure. Preferred embodiments of the present disclosure are subject of the dependent subclaims, the description and the figures.

[08] According to a first aspect of the present invention, a submersible electronics module enclosing electronics is provided, wherein the submersible electronics module has a first end section and a second end section, wherein the first end section of the submersible electronics module comprises a first coupling section being releasably couplable to a submersible pump module, wherein the second end section of the submersible electronics module comprises a second coupling section being releasably couplable to a submersible motor module, wherein the submersible electronics module comprises an intermediary drive shaft section, wherein the intermediary drive shaft section is releasably couplable to a motor drive shaft section of the submersible motor module for receiving a torque from the motor drive shaft section, and wherein the intermediary drive shaft section is releasably couplable to a pump drive shaft section of the submersible pump module for transferring the torque to the pump drive shaft section. It should be noted that the coupling between the pump drive shaft section and the intermediary drive shaft section is part of the first coupling section of the submersible electronics module, and that the coupling between the motor drive shaft section and the intermediary drive shaft section is part of the second coupling section of the submersible electronics module. The submersible pump module and the submersible motor module may be part of the same submersible pump assembly or of different submersible pump assemblies.

[09] "Axial" or "axially" shall refer herein to the direction along the longitudinal pump axis. Thus, the term "end section" is to be understood herein as an axial end section. So, the submersible electronics module is installable axially between the submersible pump module and the submersible motor module. This has benefits for many reasons. First of all,

there is no need to guide the power line laterally along the motor module, because the power line may be connected to the submersible electronics module. Therefore, the lateral space available, e.g. defined by a borehole or an opening of a tank or well, can be used more efficiently with a larger diameter of the motor. Secondly, the submersible electronics module and the submersible motor module can be repaired, maintained or exchanged independently from each other, which reduces maintenance costs. Thirdly, the submersible electronics module reduces the variety of submersible motor modules required on stack, because different kinds of submersible motor modules can be combined with the submersible electronics module as needed.

[10] It is also possible to apply the idea of the intermediate submersible electronics module disclosed herein not only for a submersible electronics module to enclose electronics, but also for a submersible module in general without electronics. A general-purpose submersible module could, for instance, be used as an adapter module, e.g. between a pump module and motor module that do not have matching coupling sections that could be coupled directly to each other.

[11] Optionally, the submersible electronics module may have a radially outer wall and a radially inner wall, wherein a closed volume of the submersible electronics module is defined radially between the radially outer wall and the radially inner wall, wherein the electronics of the submersible electronics module are arranged within said closed volume, wherein the intermediary drive shaft section is arranged radially inward from the radially inner wall and is at least partly surrounded by said closed volume in circumferential direction. Thereby, the intermediary drive shaft section may be in contact with the pump liquid that serves as a lubricant of shaft bearings within the submersible electronics module. The closed volume may thus ring the intermediary drive shaft section so that the intermediary drive shaft section is located radially inward from the closed volume, but outside of it.

[12] Optionally, the closed volume of the submersible electronics module may be hermetically closed. The closed volume may thereby be kept dry and/or filled up with a thermally conductive and electrically insulating filling medium, e.g. oil.

[13] Optionally, the submersible electronics module may have an outer diameter essentially equal to or smaller than the diameter of the submersible motor module and/or of the submersible pump module and/or of the submersible pump module. This has the advantage that the submersible electronics module does not add to the lateral extension of the submersible pump assembly as a whole. It just makes it axially longer, which is mostly acceptable. As submersible pump assemblies of this kind are primarily used to be lowered into a borehole or tank opening having a certain diameter, the submersible pump assembly should be as slim as possible while providing sufficient pumping power. Therefore, the submersible pump assemblies has preferably a slim shape with an axial length that is, for instance, ten or more times larger than its diameter. Therefore, the length of the submersible pump assembly is much less of an issue than its diameter.

[14] Optionally, the first coupling section of the submersible electronics module may essentially be identical to a coupling section of the submersible motor module, and the second coupling section of the submersible electronics module may essentially be identical to a coupling section of the submersible pump module. This is highly advantageous, because the submersible electronics module can be inserted into an already existing submersible pump assembly that is comprised of a submersible pump module and a submersible motor module being coupled to each other. These can be uncoupled and the submersible electronics module may be inserted between the submersible pump module and the submersible motor module without any hardware adaptations needed.

[15] Preferably, the first coupling section and the second coupling section are elements of a standardized coupling according to standard ANSI/NEMA MG 1-2021 part 18. This is referred to in the following as "standard NEMA coupling". The coupling section of the submersible motor module may be a male standard NEMA coupling section, whereas the coupling section of the submersible pump module may be a female standard NEMA coupling section. Accordingly, the first coupling section of the submersible electronics module may be a male standard NEMA coupling section, whereas the second coupling section of the submersible electronics module may be a female standard NEMA coupling section. It should be noted the standard NEMA coupling comprises both the coupling of the shaft sections and the coupling of the module bodies to each other.

[16] Optionally, the electronics of the submersible electronics module may comprise variable frequency drive (VFD) electronics and/or sensor electronics and/or communication electronics. So, the submersible electronics module may be a submersible VFD module and/or a submersible sensor module and/or a submersible communication module. Most preferably, the submersible electronics module comprises a combination of VFD electronics, sensor electronics and communication electronics.

[17] Optionally, the submersible electronics module may further comprise at its first end section a first end electrical connector part and at its second end section a second end electrical connector part, wherein the first end electrical connector part is configured to be connected to a power cable, and wherein the second end electrical connector part is configured to be connected to the submersible motor module. Thereby, an existing power cable that usually fits to the submersible motor module can be used to connect to the submersible electronics module. The use of the submersible electronics module therefore does not

require any adaptations or extra units in addition to the existing hardware of a submersible pump assembly.

[18] Optionally, the second end electrical connector part may be an adapter that is exchangeable to fit to an electrical connector part of the submersible motor module. This is beneficial to connect different kinds and brands of submersible motor modules that have the same standard NEMA coupling section, but a different electrical connector. The submersible electronics module therefore may act as an adapter to use the same power cable with different kinds and brands of submersible motor modules having different electrical connectors.

[19] Optionally, the first end electrical connector part may essentially be identical to an electrical connector part of the submersible motor module. In this case, there is no adapter needed at the second end section, because the electrical connector part of the submersible motor module fits to the second end electrical connector part of the submersible electronics module as well as to a power cable. A connector part of the power cable may thus be essentially identical to the second end connector part of the submersible electronics module.

[20] Optionally, at least a part of the electronics of the submersible electronics module may be arranged in thermal contact with a radially outer and/or inner wall of the submersible electronics module. This is beneficial to efficiently cool the electronics within the submersible electronics module by the liquid into which the submersible electronics module is submersed.

[21] According to a second aspect of the present disclosure, a submersible pump assembly defining a longitudinal pump axis is provided, wherein the submersible pump assembly comprises:

- a submersible pump module comprising a first end section and a second end section;

- a submersible motor module comprising a first end section and a second end section; and
- a submersible electronics module being arranged in direction of the longitudinal pump axis between the second end section of the submersible pump module and the first end section of the submersible motor module.

[22] Optionally, the first end section of the submersible motor module may comprise a first coupling section, the second end section of the submersible pump module may comprise a second coupling section, the second coupling section of the submersible pump module may be selectively couplable to the first coupling section of the submersible motor module and to a first coupling section of the submersible electronics module, and wherein the first coupling section of the submersible motor module is selectively couplable to the second coupling section of the submersible pump module and to a second coupling section of the submersible electronics module. This is particularly beneficial, because the submersible pump assembly can be selectively used with and without the submersible electronics module installed between the submersible pump module and the submersible motor module.

[23] Optionally, the submersible pump module may comprise at its first end section a pressure outlet, at its second end section a suction inlet with at least one lateral inlet opening and at least one impeller for pumping a liquid medium from the suction inlet to the pressure outlet, and wherein the submersible motor module comprises an electric motor drive for driving the at least one impeller of the submersible pump module. Typically, the operating orientation of the submersible pump assembly is such that its longitudinal axis extends vertically within a borehole, so that the first end section is a top end and the second end section is a bottom end. However, in some cases, the submersible pump assembly may have

a horizontal orientation during operation, for instance, lying on the bottom of a well or tank, or any other orientation that the surroundings allow.

[24] Optionally, the first coupling section of the submersible electronics module may be releasably coupled to the second coupling section of the submersible pump module, and the second coupling section of the submersible electronics module may be releasably coupled to the first coupling section of the submersible motor module.

[25] Optionally, each of the submersible pump module, the submersible electronics module and the submersible motor module may have an outer diameter, wherein the outer diameter of the submersible electronics module is equal to or smaller than the largest one of the outer diameters of the submersible pump module and the submersible motor module. Thereby, the outer diameter of the submersible pump assembly is not defined by the diameter of the submersible electronics module.

SUMMARY OF THE DRAWINGS

[26] Embodiments of the present disclosure will now be described by way of example with reference to the following figures of which:

Fig. 1 shows schematically an embodiment of the submersible pump assembly as disclosed herein lowered vertically into a borehole;

Figs. 2a-c show schematically the modular character of an embodiment of the submersible pump assembly as disclosed herein; and

Fig. 3 shows schematically an embodiment of the submersible electronics module as disclosed herein.

DETAILED DESCRIPTION

[27] Fig. 1 shows a submersible pump assembly 1 being lowered into borehole 3 for pumping a liquid medium 5, e.g. water, upward to a point of use (not shown) at the surface 7. The submersible pump assembly 1 is fully submersed into the liquid medium 5 to be pumped. A flexible riser duct 9 is connected to a top end 10 of the submersible pump assembly 1 for transporting the pumped liquid medium 5 upward. The flexible riser duct 9 also serves as a cable for mechanically lowering down and pulling up the submersible pump assembly 1. The submersible pump assembly 1 is electrically powered via a power line 11, which may also include a communication line.

[28] The submersible pump assembly 1 has a slim elongate shape extending over a length L along a longitudinal axis R, which is vertically aligned during the operation within the borehole 3 as shown in Fig. 1. The shape of the submersible pump assembly 1 is cylindric with a diameter D that is less than or equal to 1/10 of its length L, i.e. $L \geq 10 \cdot D$.

[29] The submersible pump assembly 1 is comprised of three submersible modules: a submersible pump module 13, a submersible motor module 15, and a submersible electronics module 17. The submersible electronics module 17 is installed axially, i.e. in direction of the longitudinal axis R, between the submersible pump module 13 and the submersible motor module 15. The submersible electronics module 17 is preferably, as in the shown embodiment, coaxially aligned with the submersible pump module 13 and/or the submersible motor module 15. The submersible electronics module 17 accommodates electronics 18 that are used during operation of the submersible pump assembly 1. The electronics 18 may comprise variable frequency drive (VFD) electronics, sensor electronics and/or communication electronics. The electronics 18 are arranged within a, preferably hermetically sealed, dry closed volume 51

(see Fig. 3) defined radially between a radially outer wall 53 of the submersible electronics module 17 and a radially inner wall 55 of the submersible electronics module 17.

[30] The top end section 10 of the submersible pump assembly 1, which is connected to the flexible riser duct 9, is defined by a first end section 10 of the submersible pump module 13 which comprises a pressure outlet 19. The flexible riser duct 9 receives the pumped liquid medium 5 from the pressure outlet 19. A (bottom) second end section 21 of the submersible pump module 13 is releasably coupled to a (top) first end section 23 of the submersible electronics module 17. A (bottom) second end section 25 of the submersible electronics module 17 is releasably coupled to a (top) first end section 27 of the submersible motor module 15. A (bottom) second end section 29 of the submersible motor module 15 defines a bottom end section 29 of the submersible pump assembly 1.

[31] The second end section 21 of the submersible pump module 13 comprises a suction inlet 31 with at least one lateral inlet opening through which the liquid medium 5 is sucked in. The submersible pump module 13 comprises in the shown example eleven stages of impellers 33 for providing sufficient pressure to pump the liquid medium 5 through the riser duct 9 all the way up to the surface 7. The impellers 33 are mechanically coupled to a pump drive shaft section 35 of the submersible pump module 13. The pump drive shaft section 35 is coaxially aligned with the longitudinal axis R and rotatable about it.

[32] The submersible motor module 15 comprises an electric motor 37 for driving the impellers 33 of the submersible pump module 13. The electric motor 37 comprises a stator 39 and a rotor 41, wherein the rotor 41 is coupled to a motor drive shaft section 43 of the submersible motor module 15. The motor drive shaft section 43 is also coaxially aligned with the longitudinal axis R and rotatable about it.

[33] The submersible electronics module 17 comprises an intermediary drive shaft section 45, wherein the intermediary drive shaft section 45 is releasably coupled, at the (bottom) second end section 25 of the submersible electronics module 17, to the motor drive shaft section 43 for receiving a torque and, at the (top) first end section 23 of the submersible electronics module 17, releasably coupled to the pump drive shaft section 35 for transferring the torque to the pump drive shaft section 35 and thus to the impellers 33. The complete drive shaft of the submersible pump assembly 1 is therefore comprised of three shaft sections: the motor drive shaft section 43, the pump drive shaft section 35, and the intermediary drive shaft section 45.

[34] Figs. 2a-c shows the modular character of the submersible pump assembly 1 as disclosed herein. Fig. 2a shows the submersible pump module 13 and the submersible motor module 15 as it may be known from the prior art. The (bottom) second end section 21 of the submersible pump module 13 is releasably couplable to the (top) first end section 27 of the submersible motor module 15. The submersible pump module 13 comprises at its (bottom) second end section 21 a female standard NEMA coupling section that engages with a male standard NEMA coupling section at the (top) first end section 27 of the submersible motor module 15.

[35] Fig. 2b shows that the submersible electronics module 17 may be installed axially between the submersible pump module 13 and the submersible motor module 15 of Fig. 2a. The submersible electronics module 17 comprises at its (top) first end section 23 a male standard NEMA coupling section that is essentially identical to the male standard NEMA coupling section at the (top) first end section 27 of the submersible motor module 15. Therefore, it can be releasably coupled to the female standard NEMA coupling section at the (bottom) second end section 21 of the submersible pump module 13. Likewise, the submersible electronics mod-

ule 17 comprises at its (bottom) second end section 25 a female standard NEMA coupling section that is essentially identical to the female standard NEMA coupling section at the (bottom) second end section 21 of the submersible pump module 13. Therefore, it can be releasably coupled to the male standard NEMA coupling section at the (top) first end section 27 of the submersible motor module 15. Fig. 2c shows the modules 13, 15, 17 coupled together to form the fully assembled submersible pump assembly 1. The embodiment of the submersible electronics module 17 shown in Figs. 2a-c comprises sensor electronics 47. So, the submersible electronics module 17 shown in Figs. 2a-c is a submersible sensor module.

[36] Fig. 3 shows another embodiment of the submersible electronics module 17 in more detail. In Fig. 3, the shown embodiment of the submersible electronics module 17 comprises variable frequency drive (VFD) electronics 49. So, the submersible electronics module 17 shown in Fig. 3 is a submersible VFD module. The VFD electronics 49 are arranged safe and dry within a closed volume 51 that is defined radially between the radially outer wall 53 and the radially inner wall 55. The intermediary drive shaft section 45 is arranged radially inward from the radially inner wall 51 and is surrounded by the closed volume 51 in circumferential direction without being inside of it. Thereby, the intermediary drive shaft section 45 is in contact with the pumped liquid medium 5 that serves as a lubricant of shaft bearings 57. Furthermore, both the radially outer wall 53 and the radially inner wall 55 are in direct thermal contact with the pumped liquid medium 5, so that it can dissipate heat to the pumped liquid medium 5. Therefore, in order to effectively cool the VFD electronics 49, they are preferably arranged in thermal contact with the radially outer wall 53 and/or the radially inner wall 55 of the submersible electronics module 17.

[37] The mechanical coupling sections of the submersible VFD module 17 of Fig. 3 are identical to the mechanical coupling sections of the submersible sensor module 17 of Fig. 2a-c, namely standard NEMA coupling sections to engage with corresponding NEMA coupling sections of the submersible pump module 13 and the submersible motor module 15, respectively. However, the submersible VFD module 17 of Fig. 3 further comprises at its (top) first end section 23 a first end electrical connector (male) part 59 and at its (bottom) second end section 25 a second end electrical connector (female) part 61. The first end electrical connector (male) part 59 is configured to be connected to the power cable 11, whereas the second end electrical connector (female) part 61 is configured to be connected to the submersible motor module 15. Preferably, the submersible motor module 15 comprises at its (top) first end section 27 an electrical connector (male) part (not shown) that is essentially identical to the first end electrical connector (male) part 59 of the submersible VFD module 17. Thereby, a power cable 11 which fits to the submersible motor module 15 can be connected to the submersible VFD module 17. A connector (female) part of the power cable 11 is thus essentially identical to the second end electrical connector (female) part 61 of the submersible electronics module 17. Otherwise, the second end electrical connector (female) part 61 may be an adapter that is exchangeable to fit to an electrical connector (male) part of the submersible motor module 15. This is beneficial to connect different kinds and brands of submersible motor modules 15 that have the same standard NEMA coupling section, but a different electrical connector. The submersible electronics module 17 therefore may act as an adapter to use the same power cable 11 with different kinds and brands of submersible motor modules 15 having different electrical connectors.

[38] Where, in the foregoing description, integers or elements are mentioned which have known, obvious or foreseeable equivalents, then such equivalents are herein incorporated as if individually set forth. Reference

should be made to the claims for determining the true scope of the present disclosure, which should be construed so as to encompass any such equivalents. It will also be appreciated by the reader that integers or features of the disclosure that are described as optional, preferable, advantageous, convenient or the like are optional and do not limit the scope of the independent claims.

[39] The above embodiments are to be understood as illustrative examples of the disclosure. It is to be understood that any feature described in relation to any one embodiment may be used alone, or in combination with other features described, and may also be used in combination with one or more features of any other of the embodiments, or any combination of any other of the embodiments. While at least one exemplary embodiment has been shown and described, it should be understood that other modifications, substitutions and alternatives are apparent to one of ordinary skill in the art and may be changed without departing from the scope of the subject matter described herein, and this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[40] In addition, "comprising" does not exclude other elements or steps, and "a" or "one" does not exclude a plural number. Furthermore, characteristics or steps which have been described with reference to one of the above exemplary embodiments may also be used in combination with other characteristics or steps of other exemplary embodiments described above. Method steps may be applied in any order or in parallel or may constitute a part or a more detailed version of another method step. It should be understood that there should be embodied within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of the contribution to the art. Such modifications, substitutions and alternatives can be made without departing from the spirit and scope of the disclosure, which should be determined from the appended claims and their legal equivalents.

[41] List of reference numerals:

1	submersible pump module
3	borehole
5	liquid medium
7	surface
9	riser duct
10	first end section of submersible pump module
11	power line
13	submersible pump module
15	submersible motor module
17	submersible electronics module
18	electronics
19	pressure outlet
21	second end section of the submersible pump module
23	first end section of the submersible electronics module
25	second end section of the submersible electronics module
27	first end section of the submersible motor module
29	second end section of the submersible motor module
31	suction inlet
33	impellers
35	pump drive shaft section
37	electric motor
39	stator
41	rotor
43	motor drive shaft section
45	intermediary drive shaft section
47	sensor electronics
49	VFD electronics
51	closed volume
53	radially outer wall
55	radially inner wall
57	bearings

59	first end electrical connector part
61	second end electrical connector part
R	longitudinal axis
L	length
D	diameter

Claims

1. A submersible electronics module (17) enclosing electronics (18, 47, 49),
wherein the submersible electronics module (17) has a first end section (23) and a second end section (25),
wherein the first end section (23) of the submersible electronics module (17) comprises a first coupling section being releasably couplable to a submersible pump module (13),
wherein the second end section (25) of the submersible electronics module (17) comprises a second coupling section being releasably couplable to a submersible motor module (15),
wherein the submersible electronics module (17) comprises an intermediary drive shaft section (45), wherein the intermediary drive shaft section (45) is releasably couplable to a motor drive shaft section (43) of the submersible motor module (15) for receiving a torque from the motor drive shaft section (43), and wherein the intermediary drive shaft section (45) is releasably couplable to a pump drive shaft section (35) of the submersible pump module (13) for transferring the torque to the pump drive shaft section (35).

2. The submersible electronics module (17) according to claim 1, wherein the submersible electronics module (17) has a radially outer wall (53) and a radially inner wall (55), wherein a closed volume (51) of the submersible electronics module (17) is defined radially between the radially outer wall (55) and the radially inner wall (53).

3. The submersible electronics module (17) according to claim 2, wherein the electronics (18, 47, 49) of the submersible electronics module (17) are arranged within said closed volume (51).

4. The submersible electronics module (17) according to claim 2 or 3, wherein the intermediary drive shaft section (45) is arranged radially inward from the radially inner wall (55) and is at least partly surrounded by said closed volume (51) in circumferential direction.

5. The submersible electronics module (17) according to any of the preceding claims, wherein the submersible electronics module (17) has an outer diameter essentially equal to or smaller than the diameter of the submersible motor module (13) and/or of the submersible pump module (15).

6. The submersible electronics module (17) according to any of the preceding claims, wherein the first coupling section of the submersible electronics module (17) is essentially identical to a coupling section of the submersible motor module (15), and wherein the second coupling section of the submersible electronics module (17) is essentially identical to a coupling section of the submersible pump module (13).

7. The submersible electronics module (17) according to any of the preceding claims, wherein the electronics (18, 47, 49) of the submersible electronics module (17) comprise variable frequency drive (VFD) electronics (49) and/or sensor electronics (47) and/or communication electronics.

8. The submersible electronics module (17) according to any of the preceding claims, further comprising at its first end section (23) a first end electrical connector part (59) and at its second end section (25) a second end electrical connector part (61), wherein the first end electrical connector part (59) is configured to be connected to a power cable (11), and wherein the second end electrical connector part (61) is configured to be connected to the submersible motor module (15).

9. The submersible electronics module (17) according to claim 8, wherein the second end electrical connector part (61) is an adapter that is exchangeable to fit to an electrical connector part of the submersible motor module (15).

10. The submersible electronics module (17) according to claim 8, wherein the first end electrical connector part (59) is essentially identical to an electrical connector part of the submersible motor module (15).

11. The submersible electronics module (17) according to any of the preceding claims, wherein at least a part of the electronics (18, 47, 49) of the submersible electronics module (17) is arranged in thermal contact with a radially outer (53) and/or inner wall (55) of the submersible electronics module (17).

12. A submersible pump assembly (1) defining a longitudinal pump axis (R), wherein the submersible pump assembly (1) comprises:
    - a submersible pump module (13) comprising a first end section (10) and a second end section (21);
    - a submersible motor module (15) comprising a first end section (27) and a second end section (29); and
    - a submersible electronics module (17) being arranged in direction of the longitudinal pump axis (R) between the second end section (21) of the submersible pump module (13) and the first end section (27) of the submersible motor module (15).

13. The submersible pump assembly (1) according to claim 12, wherein the first end section (27) of the submersible motor module (13) comprises a first coupling section, wherein the second end section (21) of the submersible pump module (13) comprises a second coupling section, wherein the second coupling section of the submersible pump module (13) is selectively couplable to a first coupling section

of the submersible motor module (15) and to the first coupling section of the submersible electronics module (17), and wherein the first coupling section of the submersible motor module (15) is selectively couplable to the second coupling section of the submersible pump module (13) and to a second coupling section of the submersible electronics module (17).

14. The submersible pump assembly (1) according to claim 12 or 13, wherein the submersible pump module (13) comprises at its first end section (10) a pressure outlet (19), at its second end section (21) a suction inlet (31) with at least one lateral inlet opening and at least one impeller (33) for pumping a liquid medium (5) from the suction inlet (31) to the pressure outlet (19), and wherein the submersible motor module (15) comprises an electric motor (39) for driving the at least one impeller (33) of the submersible pump module (13).

15. The submersible pump assembly (1) according to claim 13 or 14, wherein the first coupling section of the submersible electronics module (17) is releasably coupled to the second coupling section of the submersible pump module (13), and the second coupling section of the submersible electronics module (17) is releasably coupled to the first coupling section of the submersible motor module (15).

16. The submersible pump assembly (1) according to any of the claims claim 12 to 15, wherein each of the submersible pump module (13), the submersible electronics module (17) and the submersible motor module (15) have an outer diameter (D), wherein the outer diameter (D) of the submersible electronics module (17) is equal to or smaller than the largest one of the outer diameters (D) of the submersible pump module (13) and the submersible motor module (15).

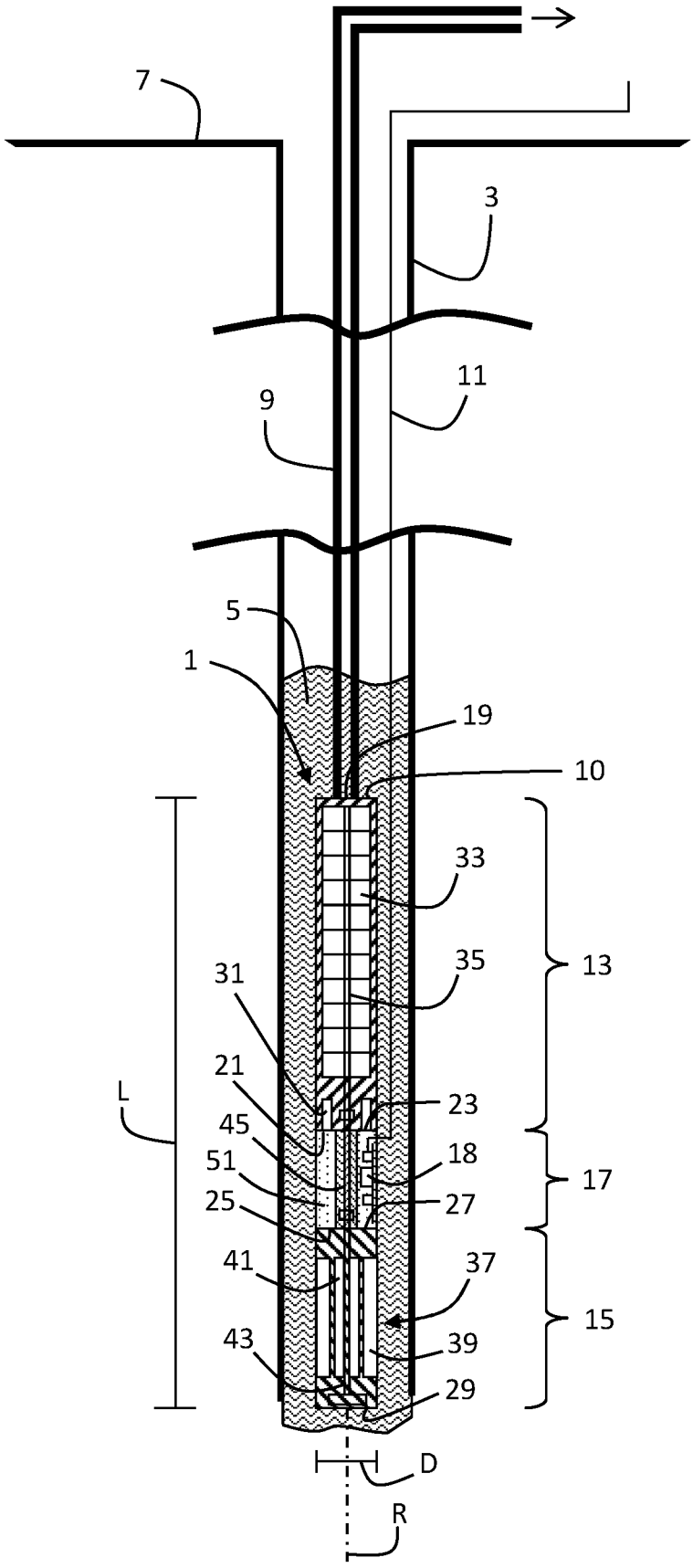
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Fig. 1

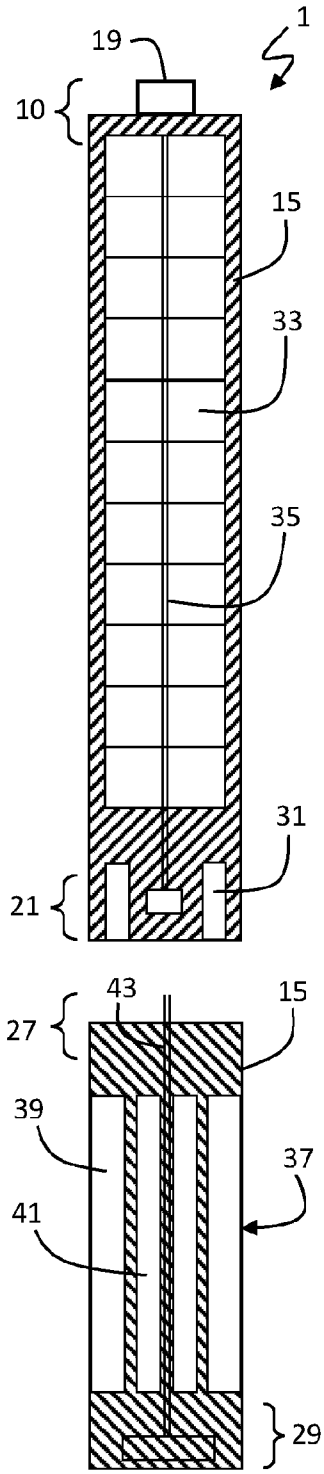

Fig. 2a

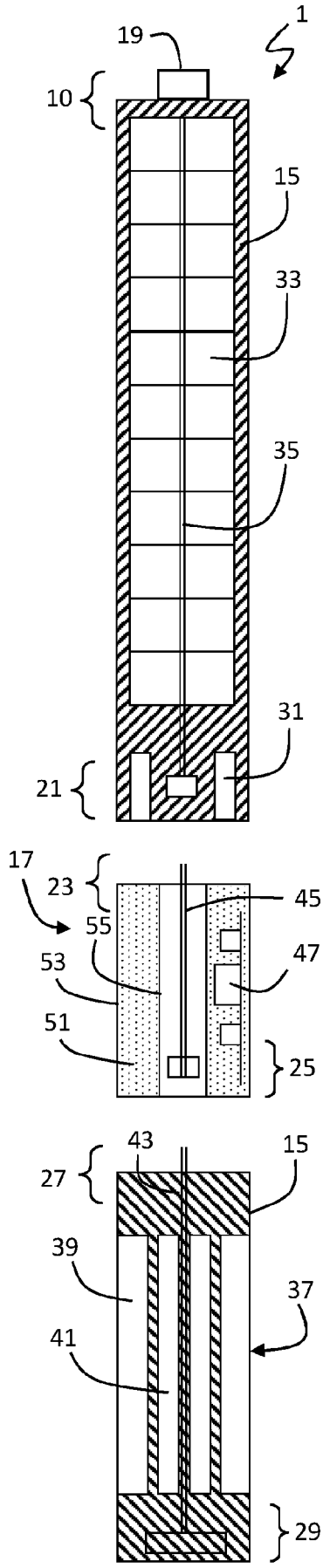

Fig. 2b

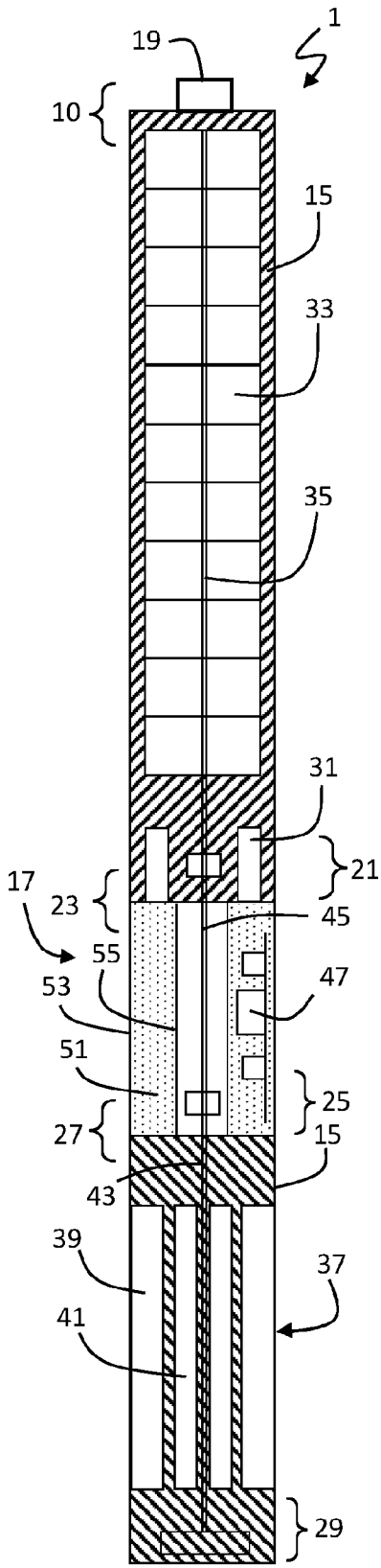

Fig. 2c

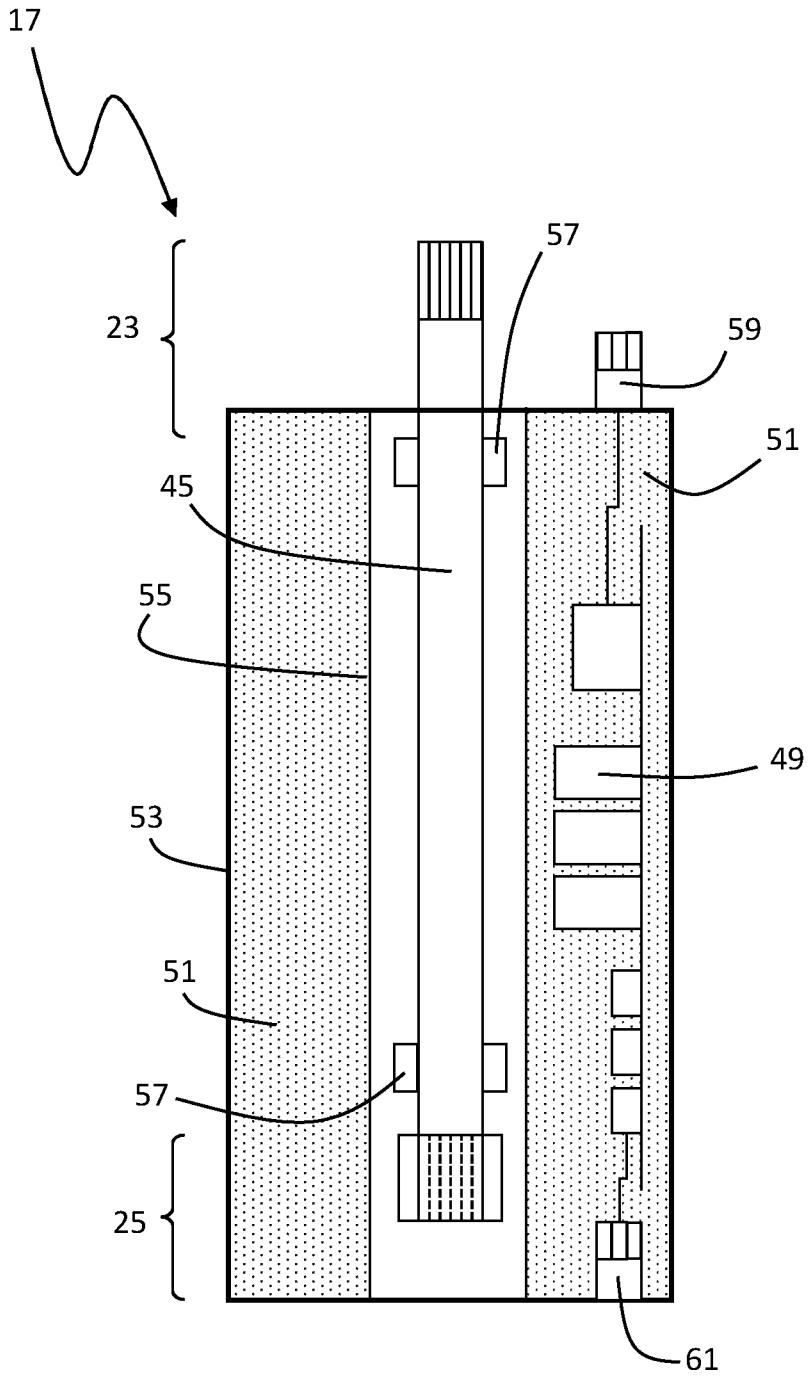

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/063100

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04D13/06 F04D13/10 F04D15/00 F04D29/62
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 36 42 727 A1 (GRUNDFOS INT [DK]) 23 June 1988 (1988-06-23)	12-16
A	abstract column 5, line 45 - column 7, line 54 claims 1,2 figures	1-11

A	IT VI20 090 306 A1 (NASTEC S R L) 24 June 2011 (2011-06-24) paragraph [0033] - paragraph [0078] figures	1-15

A	US 2011/142697 A1 (PETRUCCI PAOLO [IT]) 16 June 2011 (2011-06-16) abstract paragraph [0026] - paragraph [0068] figures	1-15

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2024	31/07/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kolby, Lars

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/063100

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2020/355189 A1 (HOEFEL ALBERT [US] ET AL) 12 November 2020 (2020-11-12) paragraph [0036] - paragraph [0053] figures 2,3	1-15

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Information on patent family members

International application No
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